

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

DIRECTIONS FOR APPLYING WINDBORNE AEROSOLS
FOR INSECT CONTROL OUT OF DOORS

By A. H. Yeomans
Division of Control Investigations

Studies have been made by us at the Agricultural Research Center, Beltsville, Md., and all over the country, on the proper method of applying windborne aerosols for the control of insects on field crops and in orchards. Windborne aerosols are those applied as a cloud and carried by the wind across the area to be treated. The fundamentals of aerosol cloud behavior have also been studied in the laboratory by use of a wind tunnel. From this background of experience the following directions for applying aerosols for control of insects out of doors have been prepared.

The insect control attained from windborne aerosols applied to field crops and orchards is due mostly to the deposit. Therefore, the considerations are directed to the factors that result in the best deposit. It is true, however, that if the aerosol is applied while the insect to be controlled is in flight, those individuals on the wing are killed as well as those that come in contact with the deposit.

Machines for applying windborne aerosols should not be confused with machines that project sprays with a powerful air blast. The air blast machine can provide a more uniform deposit across a swath with the larger spray particles than can be obtained with the windborne aerosol machine.

For satisfactory performance an aerosol cloud must be released under proper weather conditions, have uniform deposition in the selected swath width, be composed of particles of the proper size, be of the proper dosage and formulation, and be applied in the most economical manner. These requirements will be discussed.

Weather Requirements

Satisfactory movement of the aerosol cloud across the area is accomplished by making applications under the proper weather conditions. A light wind is needed, steady in direction, and moving at 1/2 to 8 m.p.h. Winds slightly stronger than 8 m.p.h. can be utilized

when the cloud is drifted uphill or when an orchard or other area with a high canopy is treated. A time of day should be selected when there is a surface inversion of temperature--i. e., when the air temperature at the ground level is cooler than at a height of 6 feet or more. Surface inversion keeps the aerosol cloud close to the ground and is most important when low-growing crops are treated and least important when trees having a canopy of foliage are treated. Good inversion usually occurs only at night from 1 hour after sunset until sunrise, but occasionally exists all day when the ground has been cooled by rain. In hilly terrain surface inversions usually occur only in the valleys. If it is necessary to make treatment in the daytime without the surface inversion, a wind of 5 to 10 m.p.h. is beneficial.

Deposition

The deposit is heaviest nearest the point of release and decreases as the distance increases, because the larger particles settle out first.

Aerosol particles moving with the wind deposit selectively on exposed vertical surfaces but settle uniformly on horizontal surfaces. The amount of deposit on the vertical surface depends on the size and shape of the object. Under similar conditions the deposit is much greater on objects of narrow width, such as pine needles, than on ones of greater width, such as maple leaves. The deposit on vertical surfaces becomes important when the aerosol is applied in winds stronger than 5 m.p.h., and on small tender foliage it is sometimes heavy enough to cause injury. When a large proportion of the foliage is exposed vertically, as in a vineyard, the increased deposition is especially important.

Experience has shown that under the best conditions only 25 to 50 percent of an aerosol containing particles of less than 50 microns mass median diameter deposits in swaths up to 2000 feet, the major portion drifting beyond the area under treatment.

The deposits of aerosols of different particle size released in a 3-m.p.h. wind under good inversion conditions are given in table 1. These deposits settled on an open field; the percentage would have been higher if the aerosol had been released through dense foliage.

Swath Width

The swath width is chosen first by the locations in the crop through which the machine can be taken with the least damage from the wheels. The minimum swath width is limited by the particle size requirements. A narrow swath requires large particles to settle out in the swath. Large particles sometimes cause foliage injury when oil solutions are used. The maximum swath width is limited by the dosage requirements. A wide swath requires a heavy output from the machine. Too heavy an

output, even though the particle size is small, will cause foliage injury due to the heavy deposit near the source. The smaller particle sizes are less efficient in depositing within a limited area. For this reason it is best to select a swath as narrow as possible without causing too much damage from the wheels of the machine or foliage injury from the large particles. Some recommended swath widths for use of DDT on various insects are given in table 2.

Particle Size

It is important to select aerosols of the proper particle size. The proper particle size depends on the swath width the aerosol is expected to cover, the wind velocity, and the amount of foliage penetration required.

After the swath width has been chosen, the particle size that will give 25 to 50 percent deposition of the aerosol at different velocities may be obtained from table 3. These values were computed for an aerosol cloud released at an average height of 10 feet and under good inversion conditions. If penetration of dense foliage is required, the particle size indicated should be reduced by one-half.

For example, 3 pounds of DDT in 3 gallons of solution released with a particle size of 40 microns across a 100-foot front in a 3-m.p.h. wind will leave a deposit of about 1 pound per acre across a 300-foot swath. If 1 pound of DDT in 1 gallon of solution is released across a 100-foot front and the particle size is raised to 70 microns, the deposit will be 1 pound per acre across a 100-foot swath with the same wind.

When the proper particle size has been selected, the aerosol machine should be set to produce this particle size according to the directions of the manufacturer.

Sometimes temporary control of flying insects is desired. The optimum particle size for this type of treatment depends upon the kind of insect, and not upon the deposit. For adult yellow-fever mosquitoes the optimum particle size has been found to be about 15 microns, and for house flies about 22 microns.

Dosage

The dosage depends on the deposit per acre of insecticide required to control the insect. It is measured by the amount applied per 100 feet of front, and varies with the swath width. Some recommended dosages of DDT against various insects are given in table 2. These values are based on the premise that 25 percent of the insecticide deposits in the first swath. Application to successive swaths results in overdrift, which increases the deposit by 10 to 20 percent in each swath. In a large field the wastage due to overdrift is thus reduced to

that from the last few swaths. For swaths less than 300 feet wide the dosage can be reduced by about 20 percent, and for swaths 300 to 500 feet wide by about 10 percent in each successive swath until the 50-percent point is reached. This reduced dosage should then be repeated to the end of the plot.

The amount of insecticide required per 100 feet can be released by two methods. The total amount required on a front can be measured, then applied by moving the aerosol generator back and forth across this front until the entire amount has been exhausted. The second method is to calibrate the output of the generator and then calculate the proper speed to move across the front to give the desired dosage. As an example, of second method only, if it is desired to release 2 gallons of solution per 100 feet from a generator with an output of 40 gallons per hour, the output per minute would be $\frac{2}{3}$ gallon. Since 1 m.p.h. is equivalent to 88 feet per minute, the speed of movement would be

$$\frac{100 \times \frac{2}{3}}{88} = 3.4 \text{ m.p.h.}$$

Formulations

To prevent rapid evaporation it is desirable that at lease one-fourth of the aerosol solution be a nonvolatile liquid. Best results have been obtained with a very concentrated solution. A much used formula is 5 to 7.5 pounds of DDT dissolved in 2 gallons of benzene or xylene plus 3 gallons of SAE 10W motor oil or an agricultural oil. An agricultural oil is used where tender foliage is present. The amount of DDT that can be dissolved in the solvent depends on the temperature. Benzene is preferable to xylene.

Benzene hexachloride, dinitro-orthocresol, pyrethrum, rotenone, toxaphene, chlordane, hexaethyl tetraphosphate, tetraethyl pyrophosphate, and nicotine have been similarly formulated. The last three insecticides are particularly noxious in aerosol form; an operator should therefore wear a proper gas mask when releasing them.

Method of Applying Aerosol

The initial impetus of the aerosol cloud, as it is emitted from the nozzle of the machine, should only place the cloud in the wind, and not deposit it on the foliage. The initial impetus is usually expended within 15 feet or less. It is preferable to point the nozzle low and back of the line of travel. The nozzle should never be pointed at foliage within the range of the initial impetus, because heavy deposit might cause burning. For treating low-growing crops the aerosol should be directed below the top of the surface inversion. When aerosols are applied in towns, the nozzle should be pointed over the tops of parked cars.

Table 1. --Effect of particle size on the percent of total insecticide depositing on 100-foot strips across a field.

Distance from release front (feet)	Mass median diameter of particles		
	75 microns	40 microns	25 microns
0-100	25.8	7.6	1.4
100-200	16.6	7.5	1.4
200-300	11.1	6.5	1.4
300-400	5.5	4.7	1.4
400-500	2.8	2.8	1.4
500-600	1.4	1.8	1.4
600-700	0.9	1.7	1.4
700-800	0.5	1.7	1.0
800-900	0.5	1.7	0.7

Table 2. --Recommended swath width and dosage of DDT for control of insects in the field with an aerosol under good conditions. [Numbers in parenthesis refer to Literature Cited.]

Insect	Stage of insect	Recommended swath width	Dosage of DDT	Approximate deposit of DDT
		Feet	Pounds per 100 feet	Pounds per acre
Cabbage looper ^{1/}	Larva	100	1	1
Armyworm ^{1/}	Larva	250	1	2/5
Leafhopper ^{1/}	Adult	500	1/2	1/10
Spotted cucumber beetle ^{1/}	Adult	100	1	1
Japanese beetle (6)	Adult	100	1	1
Lygus bug ^{1/}	Adult and nymph	250	1	2/5
False chinch bug ^{1/}	Adult and nymph	250	1	2/5
Tarnished plant bug (8)	Adult and nymph	250	1	2/5
Pentatomid (8)	Adult	250	1	2/5
Fall armyworm ^{1/}	Larva	250	1	2/5
Mosquito (1)	Adult	500	1/2	1/10
Mosquito (2) (3)	Larva	100	1	1
Sand fly (4)	Adult	150	1	2/3
House fly ^{2/}	Adult	150	1	2/3
Horn fly ^{1/}	Adult	150	1	2/3
Black fly (5)	Adult	150	1	2/3
Greenhouse whitefly ^{2/}	Adult	150	1	2/3
Potato flea beetle ^{2/}	Adult	150	1	2/3
Chinch bug ^{1/}	Adult and nymph	250	1	2/5
Gypsy moth (7)	Adult and nymph	250	1	2/5

^{1/} Tests with these insects were made by H. A. Jaynes in 1945.

^{2/} Tests with these insects were made by the author.

Table 3. --Optimum particle size, in microns mass median diameter, of aerosols for application at different swath widths

Swath width (feet)	Wind velocity in miles per hour							
	1	3	5	7 <u>1</u> / ₂	9	11	13	15
50	55	98	--	--	--	--	--	--
100	40	70	92	--	--	--	--	--
200	29	50	65	77	90	98	--	--
300	24	40	53	63	70	79	88	92
400	21	35	46	55	62	68	73	79
500	18	33	41	49	55	61	66	70
600	17	29	37	45	50	55	60	65
700	15	27	35	41	47	51	57	60
800	14	25	33	39	43	48	53	57
900	13	24	31	36	40	47	51	55
1000	13	22	29	35	39	42	48	51
1200	12	21	27	32	36	39	43	46
1500	10	18	24	29	32	35	39	40

1/₂ Application at higher wind velocity is not recommended.

Literature Cited

- (1) Brescia, Frank.
1946. Salt marsh and anopheline mosquito control by ground dispersal of DDT aerosols. Jour. Econ. Ent. 39: 698-715.
- (2) _____ and Wilson, Irwin B.
1947. Larvicidal treatment of large areas by ground dispersal of DDT aerosols. Jour. Econ. Ent. 40: 309-313.
- (3) _____
1947. Treatment of native villages with the aerosol generator. Jour. Econ. Ent. 40: 313-316.
- (4) _____
1947. Aerosol generator as used for sand fly control. Jour. Econ. Ent. 40: 316-319.
- (5) Glasgow, R. D., and Collins, D. L.
1946. The thermal aerosol fog generator for large scale application of DDT and other insecticides. Jour. Econ. Ent. 39: 227-234.
- (6) Langford, George S., and Vincent, Rufus H.
1948. Fogging with DDT for Japanese beetle control. Jour. Econ. Ent. 41: 249-251.
- (7) Latta, Randall.
1946. Field experiments with heat generated aerosols. Jour. Econ. Ent. 39: 614-619.
- (8) Snapp, Oliver I.
1948. Control of sucking bugs that cause deformed peaches. Jour. Econ. Ent. 41: 555-557.

